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World Health Organization

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**Agenda item 8** **CRD03**

**JOINT FAO/WHO FOOD STANDARDS PROGRAMME**

**CODEX COMMITTEE ON FOOD HYGIENE**

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**15 - 19 December 2025**

# REPORT OF THE PHYSICAL WORKING GROUP ON THE PROPOSED DRAFT REVISION OF THE *GUIDELINES FOR THE CONTROL OF CAMPYLOBACTER AND SALMONELLA IN CHICKEN MEAT* (CXG 78-2011)

(Prepared by the Electronic Working Group chaired by the United States of America, co-chaired by Australia, Brazil, Denmark, Honduras, and India)

## Background

A physical working group (PWG) was held on 14 December 2025 in Nashville, Tennessee immediately prior to CCFH55 chaired by the United States of America and co-chaired by Australia, Brazil, Denmark, India, and Honduras to discuss the proposed draft Guidelines for the Control of *Campylobacter* and *Salmonella* in Chicken Meat.

The Chairs presented a revised version of the guidelines, which had been amended based on comments provided in CX/FH 25/55/8 Add.1 and various CRDs. Many editorial changes were made to the document, as well as several substantive changes. The PWG reviewed the substantive changes in the document, considered the proposed revision, and made additional changes as appropriate.

## Discussion summary

The Chair began the session by focusing on topics raised in the guidelines that either garnered significant discussion or were unable to be resolved by the co-chairs and the EWG. Those topics included:

1. Alignment. The EWG presented the rationale and support for the hybrid approach to alignment due to the specific nature of the topic. This approach emphasizes alignment with CXC 1-1969 while providing the flexibility needed to accommodate an in-line flowchart that provides users with a convenient way to quickly find guidance relevant to the process of concern.
2. Finalizing the scope. The EWG-co-chairs advocated for a scope that was focused primarily on raw chicken meat from broiler carcasses and parts (raw chicken legs, breasts, and wings) and excluded raw chicken meat preparations. Maintaining targeted guidance on chicken liver to address recent reports of salmonellosis resulting from liver consumption was discussed. The co-chairs recommended that other preparations and further guidance on offal be considered as the subject of future annexes.
3. Antimicrobial resistance (AMR) stewardship. The PWG recognized the importance of ensuring responsible use of antimicrobials in pre-harvest settings and strategized on ways of including mention of the subject while staying within scope.
4. Sanitation of hatching eggs. Discussion surrounding conflicting reports of intervention efficacy and cross references with the WOAH guidelines confirmed inclusion of the guidance.

5. Risk profiles of free-ranged and controlled-environment raised chickens. The PWG discussed whether the risk profiles between the two categories were significantly different and how those risks would influence the guidance in the document.
6. Drinking water quality. The co-chairs agreed with using fit-for-purpose to describe water used in the earlier parts of broiler processing and that potable water should be used in later parts of processing. The co-chairs posed the question to the PWG whether the guidelines should include specific recommendations on water quality. The PWG agreed to not expand the guidance.
7. Litter reuse. The guidelines include general recommendations for litter reuse. The co-chairs posed the question to the PWG whether the guidelines should include more specific recommendations on the type of litter reuse treatments. The PWG agreed to not expand the guidance.
8. *Salmonella* vaccines. Guidance on the use of this intervention is new, and the PWG discussed whether sufficient evidence existed to justify their inclusion in the document.
9. Full and partial depopulation. The PWG discussed the prioritization of chicken removal from partially depopulated houses over fully depopulated houses to limit the risk of cross-contamination.
10. Temperature recommendations for various post-processing steps (e.g., processing, transport, storage). The PWG considered temperature recommendations regarding freezing and chilling during storage, transport, and food service. The previously included temperature ranges were updated to recommend a temperature of less than 5 °C where appropriate. Recognizing that further discussion on temperatures may be a new horizontal area for Codex.

**Summary of changes**

The PWG made the following changes:

1. Introduction: Added the statement “As with *Campylobacter,* it should be emphasized that these microorganisms can exist in viable but non-culturable (VBNC) states, which makes their control and detection difficult by traditional methods,”.
2. Definitions: Removed “at any stage in production” from the controlled-environment flock definition
3. 9.1 Preharvest – Flock Management – Specific flock management control measures for *Salmonella* (b). Added “FBO”
4. 9.1 Preharvest – Flock Management – Hazard-Based Control Measures – General. Added “Antimicrobial agents should only be used to control Campylobacter and Salmonella in flocks in accordance with CXC 61-2005”
5. 9.3 Slaughter and Dressing – Preslaughter – General preslaughter control measures for *Campylobacter* and *Salmonella* (b). Removed “Moribund, unhealthy, or otherwise unsuitable chickens should be isolated to avoid cross-contamination and should not be processed.
6. 9.3 Slaughter and Dressing – Slaughter – General slaughter control measures for *Campylobacter* and *Salmonella* (c). Removed, “Specific to free-range: When processing free-range flocks, consider enhanced sanitation measures to food contact surfaces, scalding, defeathering, and evisceration equipment.”
7. 9.3 Slaughter and Dressing – Scalding – Specific scalding control measures for *Campylobacter* and *Salmonella.*
    a. Removed bullet, “Raising the temperature during processing breaks high enough for a long enough time to kill Campylobacter and Salmonella in the scalders.

   b. Removed bullet, “Specific to free-range: Free-range chickens may be older, have stronger feather follicles and feathers compared to broilers raised in controlled-environment housing systems. Consider adjusting the scalding time and temperatures needed to loosen feathers and ensure adequate defeathering.

8. 9.5 Packaging and Storage at Processing – 5.3 Storage – Specific storage controls measures for Salmonella. Changed recommended temperatures from “-18 to 5°C” to “typically 5°C or below”.
9. 9.6 Distribution, Retail, and Consumers – 6.6 Consumers - General consumer control measures for Campylobacter and Salmonella (a). Added “…cooked foods”.
10. Food Service – Bracketed the temperature recommendations under bullet g. for frozen and chilled products for further discussion. The guidelines will be reviewed and aligned as appropriate to update specific temperature ranges.
11. Monitoring and Review – Added “effectiveness” to the first sentence

**Recommendations for the plenary of the 55th session of CCFH**

Consider the revised proposed draft Guidelines for the Control of *Campylobacter* and *Salmonella* in Chicken Meat to this report as the basis for discussion during the plenary session with a view to progressing the Guidelines in the Codex Step procedure (step 5/8)

**Appendix I**

**PROPOSED DRAFT REVISION OF THE *GUIDELINES FOR THE CONTROL OF CAMPYLOBACTER AND SALMONELLA IN CHICKEN MEAT* (CXG 78-2011)**

## 1. INTRODUCTION

Campylobacteriosis and salmonellosis are among the most frequently reported foodborne diseases worldwide. While numerous potential vehicles of transmission exist, raw chicken meat has been identified as one of the most important food vehicles for the transmission of these organisms. The risk in different countries varies according to control measures and practices implemented along the chain from primary production to final preparation of the meat for consumption and is impacted by geographical and climactic factors. The burden of the diseases and the cost of control measures are highly significant in many countries and contamination with *Campylobacter* and *Salmonella*[1] has the potential to severely disrupt trade between countries.

*Campylobacter* spp. are a Gram-negative, non-spore forming obligate microaerophile belonging to the family *Campylobacteraceae***.** Organisms of the genus have optimal growth at a pH between 6.5 and 7.5, and at temperatures between 4237°C and 423°C. (ICMSF 1996). *Campylobacter* spp. lack the necessary cold shock proteins to thrive at temperatures below 30 °C, however, some species can grow slowly and persist in moist environments at lower temperaturesat temperatures as low as 25 °C. *Campylobacter* spp. cannot grow when water activity ($a_w$) concentration is less than 0.987. Domestic and wild poultry are a major reservoir of *Campylobacter* with a high prevalence of *C. jejuni* and *C. coli* found in broiler chickens used in commercial production. While *C. jejuni* is the leading cause of campylobacteriosis worldwide, other species, such as *C. coli,* commonly cause human illness.

*Salmonella* spp. are a Gram-negative, non-spore forming, rod-shaped facultative anaerobes belonging to the familythe *Enterobacteriaceae* family. The genus *Salmonella* is divided into two species: *S. enterica* (comprising six subspecies) and *S. bongori*. *Salmonella* spp. can grow between 5.2°C and 46.2°C, with the optimal temperature being between 35°C and 43°C (ICMSF 1996). *Salmonella* spp. will grow over a broad pH range between 3.8 and 9.5, with an optimal pH range for growth between 7 and 7.5 (ICMSF 1996). The optimum $a_w$ for *Salmonella* is 0.99 and the lower limit for growth being 0.94. *Salmonella* spp. can survive for months or even years in foods with a low $a_w$. Over 99% of human *Salmonella* spp. infections are caused by *S. enterica* subsp. *enterica.* While all serovars can cause disease, Ppathogen virulence and public health impact can be viewed focused through the lens of serovars and virulence genes, to better focus surveillance efforts on screening for pathogens of public health concern in the global food supply. As with *Campylobacter,*

Iit should be emphasized that these microorganisms can exist in viable but non-culturable (VBNC) states, which makes their control and detection difficult by traditional methods.

These guidelines build on general food hygiene provisions already established in the Codex system and develop potential control measures specific for *Campylobacter* and *Salmonella* of public health relevance in raw chicken meat. In this context, the guidelines give effect to the Codex Alimentarius Commission (CAC) commitment to developing standards that are based on sound science and risk assessment[2][3]. Potential control measures for application at single or multiple steps are presented in the following categories:

- Good hygienic practices (GHPs). Fundamental measures and conditions applied at any step within the food chain to provide safe and suitable food. They are usually prescriptive and may differ between countries.
- Hazard-based. They are developed from scientific knowledge of the likely level of control of

[1] Human pathogens of public health relevance only. For the purposes of this document, all references to *Salmonella* and thermotolerant *Campylobacter* relate only to human pathogens.

[2] Objective 2 "Promoting widest application of scientific principles and risk analysis" of the Codex Strategic Plan 2020-2025 and the first Statement of Principle relating to the Role of Food Safety Risk Assessment "Health and safety aspects of Codex decisions and recommendations should be based on a risk assessment, as appropriate to the circumstances" Codex Procedural Manual Safety Risk Assessment "Health and safety aspects of Codex decisions and recommendations should be based on a risk assessment, as appropriate to the circumstances" Codex Procedural Manual.

[3] Objective 2 "Promoting widest application of scientific principles and risk analysis" of the Codex Strategic Plan 2020-2025 and the first Statement of Principle relating to the Role of Food Safety Risk Assessment "Health and safety aspects of Codex decisions and recommendations should be based on a risk assessment, as appropriate to the circumstances" Codex Procedural Manual Safety Risk Assessment "Health and safety aspects of Codex decisions and recommendations should be based on a risk assessment, as appropriate to the circumstances" Codex Procedural Manual.

*Campylobacter* or *Salmonella* at a step (or series of steps) in a food chain, have a quantitative basis in the prevalence and/or concentration, and can be validated as to their efficacy in hazard control at the given step. Any reduction in hazard prevalence and/or concentration has the potential to provide human health benefits depending on the type of food, stage in the food chain, intended use and preparation of the food, and consumer habits.[2][4]

Examples of hazard-based control measures have been subjected to a rigorous scientific evaluation and review in the development of these guidelines. Such examples are illustrative only and their use and adoption may vary amongst member countries. Their inclusion in these guidelines highlights the value of a quantitative approach to hazard reduction throughout the food chain and, where the decision support tool for risk-based control measures (Section 10) is applied, the likely level of public health protection that may result from implementing these control measures at the national level.

These guidelines are presented in a flow diagram format to enhance practical application of a primary production to consumption approach to food safety. This format:

- Demonstrates differences and commonalities in control measures for *Campylobacter* and *Salmonella*
- Illustrates relationships between control measures applied at different steps in the food chain
- Facilitates development of Hazard Analysis Critical Control Point (HACCP) plans at individual premises and national levels
- Assists in judging the equivalence[5] and appropriateness of control measures for raw chicken meat applied in different countries

These guidelines provide flexibility for use at the national (and individual primary production and processing) level.

## 2. OBJECTIVES

The primary objective of these guidelines is to provide information to ~~governments~~ competent authorities and ~~industry~~ food business operators on the control of *Campylobacter* and *Salmonella* in raw chicken meat to reduce foodborne disease from this source whilst ensuring fair practices in international food trade. The Guidelines provide a scientifically sound international tool for robust application of GHP and hazard-based approaches to control *Campylobacter* and *Salmonella* in raw chicken meat according to national risk management decisions.

It is not the intention of these guidelines to set quantitative limits for *Campylobacter* and *Salmonella* in raw chicken meat for international trade. Rather, the Guidelines follow the example of the overarching Codex *Code of Hygienic Practice for Meat* (CXC 58-2005) and provide an enabling framework that countries can use to establish control measures appropriate to their national situation. As a result, control measures may vary between production systems and countries.

## 3. SCOPE

These guidelines apply to the control of all *Campylobacter* and *Salmonella* that may contaminate raw chicken meat (*Gallus gallus*) and cause foodborne disease. The primary focus is raw chicken meat in the form of broiler carcasses and parts (e.g., raw chicken legs, breasts, and wings). These guidelines do not include recommendations for ~~raw chicken meat~~further preparations (i.e., raw chicken meat which has had foodstuffs, seasonings or additives added to it). These guidelines can be applied to other classes of chickens, e.g., end-of-lays, as appropriate. While significant consumer exposure may occur from consumption of further processed products such as ground/minced meat, and raw chicken meat preparations (raw chicken meat which has had foodstuffs, seasonings or additives added to it) and ~~offals~~offal, these guidelines do not include any specific recommendations for these products as cooking is the primary control measure after processing.

While the biosecurity provisions in this document have been developed primarily for chickens raised in controlled-environment housing systems, they also have applicability to other housing systems such as free-range. Where appropriate, free-range specific guidelines are noted.

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[4] ~~JEMRA, 2002. Risk Assessments of *Salmonella* in Eggs and Broiler Chickens. FAO/WHO Microbial Risk Assessment Series No. 2. Joint FAO/WHO Expert Committee for Microbial Risk Assessment. JEMRA, 2009. Risk Assessment of *Campylobacter* spp. in Broiler Chickens, Technical Report. FAO/WHO Microbial Risk Assessment Series No. 12 Joint FAO/WHO Expert Committee for Microbial Risk Assessment~~

[5] Codex *Guidelines on the Judgement of Equivalence of Sanitary Measures Associated with Food Inspection and Certification Systems* (CXG 53-2003).

## 4. USE

These guidelines describe specific guidance for control of *Campylobacter* and *Salmonella* in raw chicken meat according to a "primary production to consumption" food chain approach. Potential control measures are considered at each step, or group of steps, in the process flow.

These guidelines are supplementary to and should be used in conjunction with the Code of Practice – General Principles of Food Hygiene (CXC 1 – 1969), the Code of Hygienic Practice for Meat (CXC 58-2005), the Code of Practice for the Processing and Handling of Quick Frozen Foods (CXC 8-1976), the WOAH *Terrestrial Animal Health Code*, and the Code of Practice on Good Animal Feeding (CXC 54-2004).

General and overarching provisions are referenced as appropriate, and their content is not duplicated in these guidelines.

The guidelines systematically present GHP-based control measures and examples of hazard-based control measures. GHPs are pre-requisites to selecting hazard-based control measures. Examples of hazard-based control measures are limited to those that have been scientifically evaluated as being effective under conditions of commercial use. Where no quantifiable outcome is mentioned for a specific control measure, it should be noted that the effect may be different between *Salmonella* and *Campylobacter.* lCountries should also note that these hazard-based control measures are indicative only and the references provided should be reviewed to assist application. The quantifiable outcomeitts reported for control measures are specific to the conditions of particular studies and would need to be validated under local commercial conditions to provide a meaningful estimate of hazard reduction.[5] ~~Government~~ Competent authorities and Food Business Operators (FBO)~~industry~~ can choose hazard-based control measures to inform decisions on critical control points when applying HACCP principles to a particular food process.

Several hazard-based control measures as presented in these guidelines are based on the use of chemical decontaminants to reduce the prevalence and/or concentration of *Campylobacter* and/or *Salmonella* in broiler carcasses. Where chemical decontaminants are considered necessary, the processor should conduct studies to determine the most effective processing step for their use. The use of these control measures, including chemical decontaminants where relevant, in the food chain, is subject to approval by the competent authority[6], where appropriate. The use of chemical decontaminants does not replace good hygienic practices in slaughterhouses and processing facilities and biosecurity measures at the farms of origin. Also, these guidelines do not preclude any other choice of a hazard-based control measure that is not included in the examples.

Provision of flexibility in the application of these guidelines is an important attribute. They are primarily intended for use by ~~government risk managers~~competent authorities and food business operators~~industry~~ in the design and implementation of food safety control systems.

The Guidelines can be useful when judging the equivalence and assessing the appropriateness of different food safety measures for raw chicken meat in different countries.

## 5. GENERAL PRINCIPLES

Refer to the General Principles of Food Hygiene (CXC 1-1969).

Overarching principles for good hygienic practice for meat are presented in the Code of Hygienic Practice for Meat (CXC 58-2005) section 4: General Principles of Meat Hygiene. Two principles that have particular relevance to these guidelines are:

- The principles of food safety risk analysis should be incorporated wherever possible and appropriate in the control of *Campylobacter* and *Salmonella* in raw chicken meat from primary production to consumption.
- Wherever possible and practical, Competent Authorities should formulate risk management metrics[7] to objectively express the level of control of Campylobacter and Salmonella in raw chicken meat that is required to meet public health goals.

## 6. DEFINITIONS

[6] Competent authority as defined in CXC-1 1969, "The government authority or official body authorized by the government that is responsible for the setting of regulatory food safety requirements and/or for the organization of official controls including enforcement.

[7] *Principles and Guidelines for the Conduct of Microbiological Risk Management* (MRM) CXG 63-2007

For the purpose of this document, definitions of the *General Principles of Food Hygiene* (CXC 1-1969), the *Code of Hygienic Practice for Meat* (CXC 58-2005), and the following definitions apply:

**Biosecurity**: Set of management and physical measures designed to reduce the risk of introduction, establishment and spread of animal diseases, infections or infestations to, from and within an animal population.

**Broiler**: Birds of the species *Gallus gallus* selectively bred and reared for their meat rather than eggs.

**Chicken**: Birds of the species *Gallus gallus.*

**Competitive exclusion**[8]: Administration of defined[9] or undefined bacterial formulations to poultry to prevent gut colonization by enteropathogens, including *Campylobacter* and *Salmonella*.

**Controlled-environment flock:** Flocks raised in enclosed housing or barns without access to the outside environment ~~at any stage in production~~.

**Crate**: Container used to transport live chickens.

**Fit-for-purpose water**[10]: Water that is determined to be safe for an intended purpose through the identification, evaluation, and understanding of potential microbiological hazards and other relevant factors (e.g., history of use, the intended use of the food, etc.), including the application of control measures such as treatment options and their efficacy to ensure effective elimination or mitigation of such hazards.

**Flock**: Group of chickens raised ~~and/~~or handled together ~~and~~ which share a common environment, ~~and~~ management and biosecurity practices that affect the likelihood of exposure to a pathogenic agent.

**Free-range flock:** Flocks raised in housing with access to the outside environment.

~~**Controlled-environment flock:** Flocks raised in enclosed housing or barns without access to the outside environment at any stage in production.~~

**Horizontal transmission**: Transmission of infectious disease or pathogens between birds of the same generation sharing the same living space.

~~**Vertical transmission:** Transmission of infectious disease or pathogens from a parent bird to an offspring through the egg.~~

**Module**: Structure containing crates / cages that facilitates loading and unloading.

**Partial depopulation**: Incomplete harvest, thinning, or "catching" of chickens from a growing flock that, for the purposes of this document, will be transported to slaughter.

**Potable water**: Water fit for human consumption. This refers to water that is safe and satisfactory for drinking and cooking.

**Total depopulation**: Full harvest or "catching" of chickens from a growing flock that, for the purposes of this document, will be transported to slaughter.

**Vertical transmission:** Transmission of infectious disease or pathogens from a parent bird to an offspring through the egg.

## 7. RISK MANAGEMENT AND RISK PROFILES

These guidelines apply a risk management framework (RMF) approach as advocated in the Codex *Principles and Guidelines for the Conduct of Microbiological Risk Management (MRM)* (CXG 63-2007). Preliminary microbiological risk management activities and identification and selection of risk management options are represented by the guidance developed for control measures at each step in the food chain. Following sections on "Implementation" and "Monitoring" complete the application of all the components of the RMF.

Risk profiles are an important part of preliminary risk management activities when applying an RMF to a food safety issue. They provide scientific information to risk managers and industry in the design of food safety control

[8] This definition is taken directly from the WOAH *Terrestrial Animal Health Code*.
[9] Probiotics may be competitive exclusion products
[10] This definition is taken directly from the *Guidelines for the safe use and reuse of water in food production and processing* CXG 100-2023

systems that are tailor-made to individual food production and processing systems.

The contents of these guidelines are predicated on two extensive risk profiles on *Salmonella* and *Campylobacter* in broiler chicken:

- Measures for the control of non-typhoidal *Salmonella* spp. poultry meat: Meeting report (2023)[11]
- Measures for the control of *Campylobacter* spp. in chicken meat: Meeting report (2024)[12]

## 8. INTRODUCTION AND CONTROL OF FOOD HAZARDS

Refer to the *General Principles of Food Hygiene* (CXC 1-1969).

## 9. PRIMARY PRODUCTION TO CONSUMPTION APPROACH TO CONTROL MEASURES

These guidelines incorporate a "primary production to consumption" flow diagram which includes guidance from *General Principles of Food Hygiene* (CXC 1-1969) in each section and identifies all steps in the food chain where control measures can potentially be applied. It facilitates a systematic approach to the identification and evaluation of all potential control measures. Consideration of all steps in the food chain allows different combinations of control measures to be developed. This is particularly important where differences between countries occur in primary production and processing systems and risk managers need the flexibility to choose risk management options that are appropriate in the national context. General guidelines at each step refer to GHP measures and where appropriate, hazard-based recommendations are noted in text boxes.

Unless otherwise specified, where appropriate, the general principles for primary production, establishment design and equipment, training and competence, establishment maintenance, personal hygiene, control of operation, product information, ~~and~~ consumer awareness, ~~and~~ transportation ~~apply~~, and HACCP system and guidelines for its application apply. Refer to the *General Principles of Food Hygiene* (CXC 1-1969) ~~— sections 8-15~~.

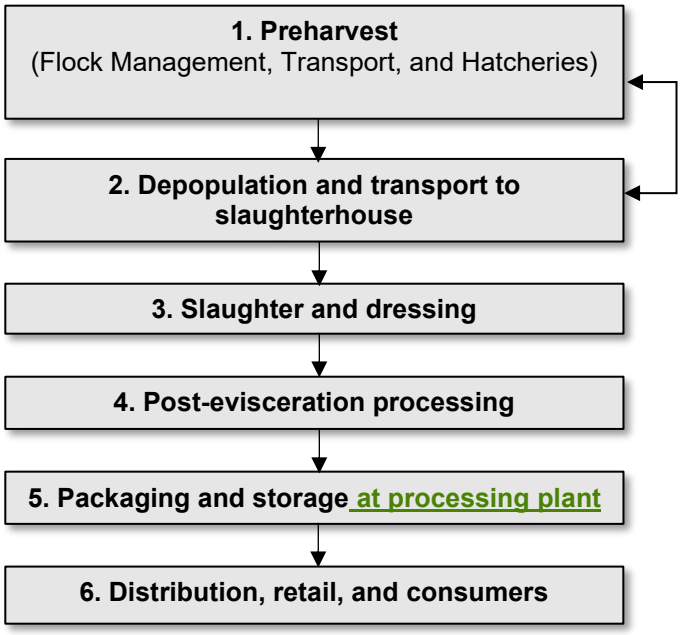
Where applicable, criteria should be established to verify the efficacy and performance of control measures designed to mitigate the presence of *Campylobacter* and *Salmonella* throughout the farm and production process that considers pathogen-specific risk factors, the distribution of microorganisms in raw chicken meat at various stages of production, potential changes to microflora during storage and distribution, and the intended use of the final product. Refer to the Principles for the Establishment and Application of Microbiological Criteria for Foods (CXG 21-1997) and section IV of the *Guidelines for the Validation of Food Safety Control Measures* (CXG 69 - 2008).

### Generic flow diagram for application of control measures

A generic flow diagram is presented in sequence on the following pages. Individual premises will have variations in process flow and should adapt the design of HACCP plans accordingly when applied.

[11] https://www.who.int/publications/i/item/9789240078826
[12] https://www.who.int/publications/i/item/9789240088085

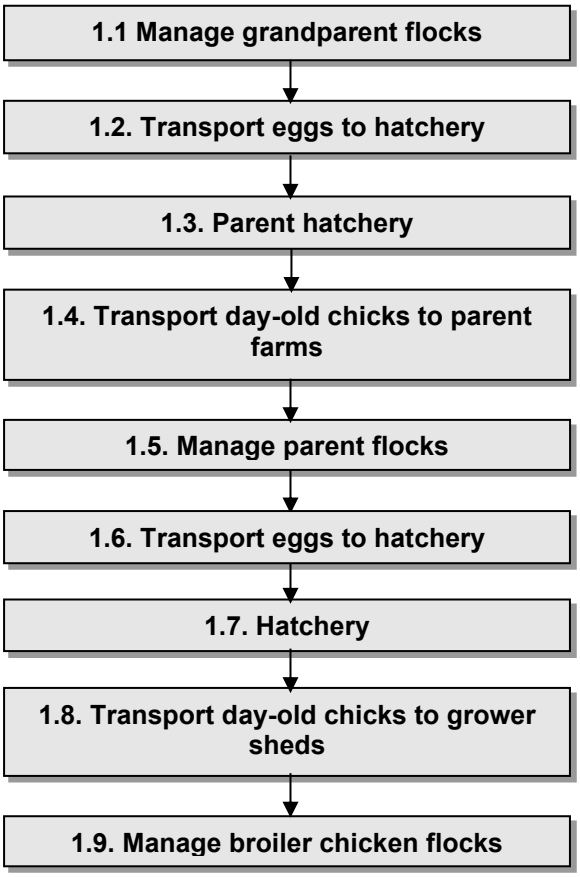
***Figure 1.*** *Example flow diagram of ~~poultry~~ chicken primary production to consumption*




*Source: Authors' own elaboration based on CXG 78-2011.*

## 9.1 Preharvest (Flock Management, Transport, and Hatcheries)

***Figure 2.*** *Example flow diagram of ~~poultry~~ chicken primary production*




*Source: Authors' own elaboration based on CXG 78-2011.*

**Flock management (Steps 1.1, 1.5, and 1.9)**

Control of *Campylobacter* and *Salmonella* in ~~poultry~~ chicken flocks is strengthened by the application of a combination of biosecurity and personnel hygiene measures. This combination of control measures adopted at a national level should be determined in consultation with relevant stakeholders. The recommendations in this section are applicable for all stages of flock management.

General flock management control measures for *Campylobacter* and *Salmonella*

a. When designing or maintaining production farms, consideration should be given to ensure adequate ventilation, air quality, humidity, temperature, lighting, flock welfare, housing type, population density, building age, and ~~layouts that~~layouts that ~~provide easy~~facilitate access for cleaning and disinfection to reduce contamination levels and the potential for horizontal transmission.

b. Staff training and strict compliance with biosecurity and personnel hygiene measures are necessary to ensure effective management systems and to prevent contamination to subsequent flocks in the same house. Infected broiler flocks increase the risk of spread in the slaughter environment and the potential for contamination of raw chicken meat.

~~a.~~c. Production systems utilizing outdoor areas should consider risks associated with exposure to external environmental hazards (e.g., soil, vegetation cover, wild birds, pests, standing water).

~~b.~~d. Pest control programs should be specific to the challenges in a given farm or geographic location and may include a combination of physical, chemical, and biological control methods~~factors~~. Use of chemical pesticides may require approval by a competent authority.

~~c.~~e. Measures such as change-in-change-out or shower-in-shower-out in an anteroom where possible should be implemented for ~~poultry~~ chicken house workers.

f. Removal of organic material should be carried out prior to cleaning. Cleaning and disinfection protocols should include critical locations in such as drinking cups, drain holes, and floor cracks.

~~d.~~g. Reused litter should be managed or treated to inactivate pathogens (e.g., composting, chemical treatments). Treated litter should be tested to confirm efficacy prior to reuse. ~~Cleaning and disinfection protocols should involve~~ include ~~critical locations in broiler houses such as drinking cups, drain holes, and floor cracks.~~

~~e.~~h. The use of dedicated tools, equipment, biosecurity barriers, and personal protective equipment (PPE) for individual flock houses and separated paddocks on farms is an effective way to reduce the risk of transmission.

~~f.~~i. Total depopulation of the flock should be carried out where possible. Where this is not practicable and partial depopulation is practiced, particular attention should be paid to strict biosecurity and hygiene of catchers and the equipment they use to minimize the risk of ~~cross contamination~~cross-contamination between flocks.

~~g.~~j. Proper cleaning and disinfection of crates, catcher's clothing, and transport vehicles is critical when catchers move between farms, ~~-~~and especially after total depopulation. These measures are ~~is~~ essential to reduce the risk of contamination.

~~h.~~k. Feed should be ~~treated, stored, and delivered~~handled in a manner that prevents contamination. Feed should preferably be delivered in dedicated vehicles or in closed containers used only for feed transport. The effectiveness of these measures can be verified by testing critical control points~~by testing critical control points~~ (e.g., feed, dust from feed silos, storage containers).

~~i.~~l. Specific to free-range production systems:

Free-range flocks interact with the outdoor environment and that can increase their exposure and risk of contamination and colonization with *Campylobacter* and *Salmonella*. Access to areas where wild birds visit (e.g., trees, vegetation, water sources) should be limited and FBOs should consider keeping feed, feeders, and drinking water indoors or sequestered from wildlife and pests to discourage wild birds from populating outdoor areas used by free-range birds. Farms should include secure housing that can be used, when necessary, to sequester chickens from wild birds and other animals.

Farms should assess previous and current land uses and should evaluate contamination risks for free-range areas and birds. Any unique risks associated with accessing outdoor areas should be managed (e.g., monitoring the environment, evaluating whether the~~that~~ time between livestock grazing and foraging by a flock is sufficient).

If litter is used in outdoor areas, it should be kept dry and regularly rotated out of the free-range area.

Specific flock management control measures for *Campylobacter*

~~For non-free-range situations, t~~The use of fly screens to reduce or eliminate fly infestation in broiler houses has been shown to decrease the percentage of *Campylobacter*-positive flocks in controlled-environment housing~~,~~ when implemented with other biosecurity measures. Where flyscreens are deployed, fans with adequate power should be installed to ensure sufficient air circulation and screens should be cleaned frequently to keep them clear of feathers and detritus.

Specific flock management control measures for *Salmonella*

a. The use of *Salmonella*-infected eggs will increase the likelihood of the flock being infected. As an additional measure for breeders to reduce contamination of chicks after incubation, hatching eggs should be cleaned and sanitized as soon as possible after collection, using an appropriate sanitation regime.~~a sanitizing agent, according to the guidance of a veterinarian.~~

b. Where possible, ~~bWhere possible, b~~reeder flocks should be *Salmonella*-free at both the parent and grandparent flock levels. The sampling frequency in breeders should allow the FBO and/or competent authority to ~~take~~implement control measures before progeny chicks are transported from the hatchery.

c. When a flock is found to be *Salmonella*-positive, a range of responses, detailed in the WOAH *Terrestrial Animal Health Code*, ~~chapter 6.6~~ "Prevention, Detection and Control of *Salmonella* in Poultry", should be implemented. Surveillance and traceback requirements should be designed by a competent authority and based on contextually relevant public health concerns.

d. Where feasible (e.g., in countries or situations with low *Salmonella* prevalence), depopulation of *Salmonella*-

positive breeder flocks can reduce the risk of horizontal and vertical transmission[13]. ~~Infected broiler flocks increase the risk of spread in the slaughter environment and the potential for contamination of raw chicken meat.~~

**Flock Management Hazard-Based Control Measures**

~~Genera~~General

- Antimicrobial agents should only be used to control *Campylobacter and Salmonella* in flocks in accordance with CXC 61-2005

**Specific to *Salmonella***

- The use of control measures such as probiotics, prebiotics, competitive exclusion bacteria, organic acids in pre- slaughter drinking water, and organic acids (e.g., formic acid combined with propionic acid) or formaldehyde in feed, may reduce ~~the~~ prevalence when used in a multi-hurdle approach with other measures. The use may require approval by a competent authority
- Vaccination of breeders and broilers with live or inactivated *Salmonella* vaccines, done according to manufacturer's instructions, has shown to be effective in reducing the prevalence of *Salmonella* at the slaughterhouse. Vaccination of breeder chickens has been shown to be effective at reducing vertical transmission of *Salmonella*
- The use of live and inactivated vaccines may require approval by the competent authority to permit their use

**Transport – Hatchery Eggs and Live Birds (Steps 1.2, 1.4, 1.6, and 1.8)**

The recommendations in this section are applicable for all references to transportation of eggs to hatchery and live birds.

General eggs and live bird transport control measures for *Campylobacter* and *Salmonella*

a. Personnel involved in the transportation of live birds should follow appropriate biosecurity procedures to avoid cross-contamination of live birds during loading and unloading. All live bird transport trucks, crates and modules should be effectively cleaned, disinfected, and dried on site ~~to the greatest extent practicable~~ before reuse.

b. Personnel should not enter any buildings used to house livestock without following appropriate biosecurity protocols. Measures should be taken to prevent cross-contamination of live birds during loading and unloading.

Specific eggs and live bird transport control measures for *Salmonella*

a. Only eggs from *Salmonella*-negative flocks should be transported for hatching. When this is not practical, the eggs from *Salmonella*-positive flocks should be transported separately from other eggs and either discarded or handled according to guidance established by a competent authority.

b. Where possible, ~~E~~eggs from *Salmonella*-positive flocks should not be used for propagation. This may not possible where there is a limitation on the methods of analysis and/or the use of eggs from *Salmonella*-positive flocks is ~~except where~~ necessary to maintain food security.

c. ~~L~~Lining paper ~~should be~~ used in crates used to transport chicks is an effective critical control point that may~~to~~ facilitate verification testing for *Salmonella* in flocks.

**Hatchery Management (Steps 1.3 and 1.7)**

The recommendations in this section are applicable for all stages of hatchery management.

General hatchery management control measures for *Campylobacter* and *Salmonella*

[13] Transmission of infectious disease or pathogens from a parent bird to an offspring through an egg.

~~Trace back of contamination to the infected breeder flocks should be performed and control measures should be reviewed.~~

Measures such as change-in-change-out or shower-in-shower-out in an anteroom where possible should be implemented for ~~poultry~~ chicken house workers.

Specific hatchery management control measures for *Salmonella*

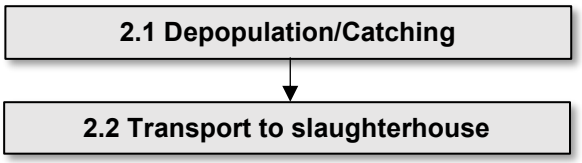
a. If possible, only eggs from *Salmonella*-negative flocks should be hatched.

b. Trace back of contamination to the infected breeder flocks should be performed and control measures should be reviewed.

c. Where the use of shared equipment is unavoidable, such as conveyors for hatching incubators, chicks hatched from *Salmonella*-negative flocks should be conveyed and packed before chicks from *Salmonella*-positive flocks. Conveyors and related equipment should be thoroughly cleaned~~,~~ and sanitized~~, and tested~~ before reuse for chicks from *Salmonella*-negative flocks. Testing and monitoring should be implemented to verify sanitation efficacy.

## 9.2 Depopulation and Transport to Slaughterhouse

***Figure 3.*** *Example flow diagram of depopulation and transport to slaughterhouse*




*Source: Authors' own elaboration based on CXG 78-2011.*

General depopulation and transport control measures for *Campylobacter* and *Salmonella*

a. Total depopulation or catching of the entire flock is recommended and should be carried out at one time. Where this is not feasible, partial depopulation can be performed. Because partial depopulation carries an increased risk of contamination and transmission of pathogens, particular attention should be paid to strict biosecurity, catcher hygiene, ~~and hygiene of catchers~~ and the equipment used.

b. ~~Poultry~~ Chicken houses and outdoor areas should have dedicated tools and PPE for partial depopulation. It is strongly recommended that ~~S~~sheds ~~must~~ be thoroughly cleaned and sanitized after full depopulation~~use~~.

c. Measures such as change-in-change-out or shower-in-shower-out in an anteroom where possible should be implemented for ~~poultry~~ chicken house workers.

d. When partial depopulation is scheduled on the same day as total depopulation, it is preferable to catch birds from ~~partially depopulated poultry~~ chicken houses scheduled for partial depopulation before those being fully depopulated. This minimizes the risk of contamination and transmission of pathogens to areas where live birds will continue to be maintained ~~for a period of time~~.

~~e. In mixed-farm situations (a combination of controlled-environment housing and free-range flocks) where partial depopulation is practiced, or where catchers move between farms, house-raised lower risk flocks should be caught prior to the free-rangehigher risk flocks to minimize the risk of horizontal transmission from higher-risk free-range flocks. The risk status of a flock is dependent on the specific circumstances of the flock and should be determined prior to partial depopulation.~~

~~f. Farm workers should take additional biosecurity and sanitation measures to minimize cross-contamination from free-range areas contaminating the flock prior to harvest.~~

e. All live-bird transport trucks, crates, and modules should be effectively cleaned, disinfected, and dried~~, and tested to the greatest extent practicable,~~ before reuse.

f. Specific to free-range production systems:

In mixed-farm situations (a combination of controlled-environment housing and free-range flocks) where partial depopulation is practiced, or where catchers move between farms, flocks raised in controlled-environment housing should be caught prior to the free-range flocks to minimize the risk of horizontal transmission. The risk status of a flock is dependent on the individual circumstances of the flock and should be determined prior to partial depopulation.

Farm workers should take additional biosecurity and sanitation measures to minimize cross-contamination from free-range areas prior to harvest.

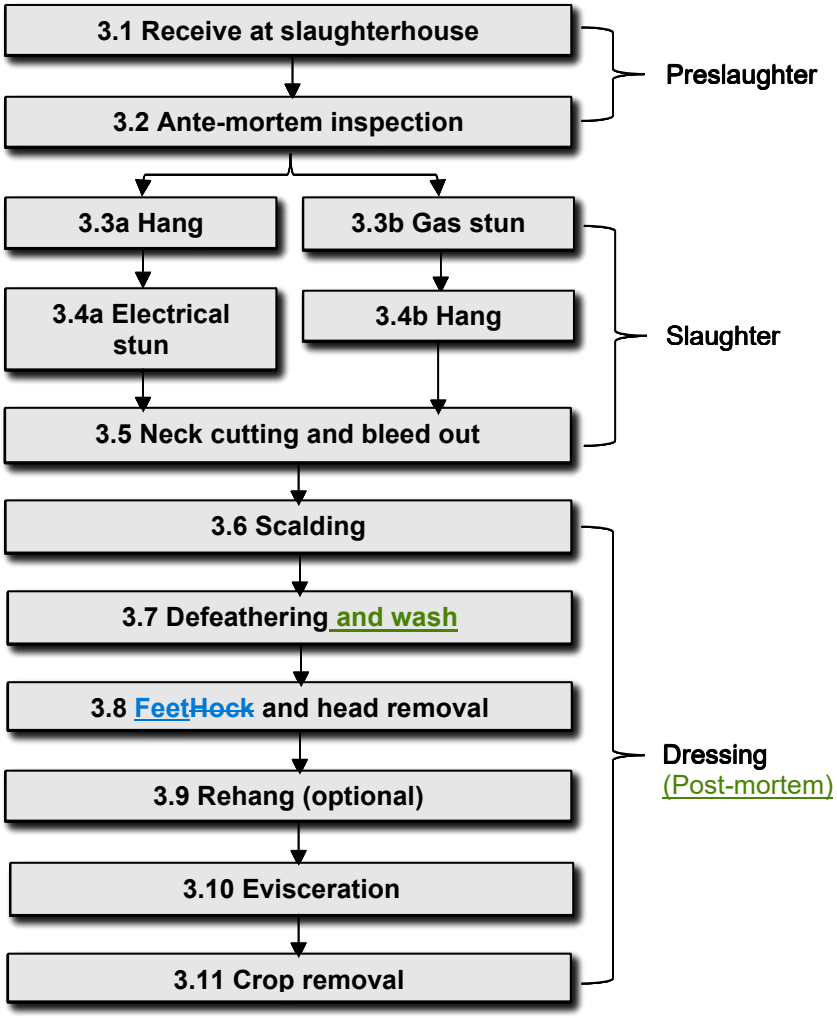
**Depopulation and Transport Hazard-Based Control Measures**

**General**

- Ensure appropriate feed withdrawal fasting ~~of~~(~~typically~~usually a minimum of 8-12 hours) prior to slaughter to minimize gastrointestinal spillage during processing~~.~~
- When feed withdrawal is practiced, water additives such as lactic acid may be used to acidify the crop contents and reduce bacterial contamination of the crop, which can rupture during processing and lead to cross-contamination~~.~~

## 9.3 Slaughter and Dressing

***Figure 4.*** *Example flow diagram of slaughter and dressing*




*Source: Authors' own elaboration based on CXG 78-2011.*

**Preslaughter (Steps 3.1 and 3.2)**

General preslaughter control measures for *Campylobacter* and *Salmonella*

a. ~~Stress to chickens should be minimized~~Animal welfare should be supported~~,~~ through measures such as ~~-~~dim lighting, minimizing noise, optimal temperature, weather protection, minimal handling and avoiding delays in processing[14].

~~b.~~a. ~~Moribund, unhealthy, or otherwise unsuitable chickens should be isolated to avoid cross contamination~~cross-~~contamination and should not be processed~~ ~~not be processed~~.

~~c.~~b. ~~Where numbers of chickens that are dead on arrival, moribund, unhealthy or otherwise unsuitable for processing exceed expected levels, the processor should notify the relevant responsible person, e.g. the competent authority, the farmer, veterinarian, catcher or transportation company, so that appropriate preventative and/or corrective action can be taken.~~Poultry producers should provide documentation detailing flock health status and medication history to assist slaughter establishments in risk identification and intervention selection before slaughter.

c. Specific~~-~~ to free-range: FBOs should have a management plan and process control measures to prevent ~~cross contamination~~cross-contamination between controlled~~--~~environment and free-range flocks. ~~.Flocks should be slaughtered at the end of a processing period to minimize cross-contamination and equipment should be sanitized between the processing of different flocks.~~

Specific preslaughter control measures for *Salmonella*

Where appropriate to the national situation, information about the *Salmonella* status should be provided to the establishment and competent authorities in a timely manner to ~~enable~~ allow for logistical slaughter planning and/or diversion~~ting~~ of raw chicken meat to appropriate intervention measures.~~.~~

**Slaughter (Steps 3.3 to 3.5)**

General slaughter control measures for *Campylobacter* and *Salmonella*

a. Where applicable, ~~M~~measures should be taken to minimize bird stress at live hanging, (e.g., use of blue light, breast comforter and suitable line speed).

b. Birds must be slaughtered in accordance with good commercial practices in a manner that will result in thorough bleeding of the carcasses and ensure that ~~breathing has stopped~~chickens are dead prior to scalding. ~~Bleeding should be thorough, and workers should confirm that the chickens are no longer breathing before scalding can begin.~~ In addition to ensuring proper animal welfare, this will reduce the amount of blood entering the scalder[14]~~.~~

~~b.~~c. Hangers and transport trolleys should have a validated protocol that includes washing, disinfection, and rinsing to reduce ~~prevalence~~cross-contamination between carcasses.

~~c. Specific to free-range: When processing free-range flocks, consider enhanced sanitation measures to food contact surfaces, scalding, defeathering, and evisceration equipment.~~

Specific slaughter control measures for *Salmonella*

Where appropriate to the national situation:

~~a. Screen flocks prior to slaughter to determine their *Salmonella* status and~~ Aapply logistic slaughter which prioritizes slaughter of ~~uninfected~~ *Salmonella*-negative flocks first and slaughter of *Salmonella*-positive ~~colonized~~ flocks at the end of the day or week.

a.

~~b.~~ Positive flocks may be diverted for specific processing and/or treatment. ~~according to national food safety policies.~~

b.

**Slaughter Hazard-Based Control Measures**

**General**

Where practical, flocks should be slaughtered after 8-12 hours of feed withdrawal in order to reduce the likelihood of contamination of carcasses by fecal material and ingesta

**Dressing (Steps 3.6 to 3.11)**

General dressing control measures for *Campylobacter* and *Salmonella*

a. To minimize carcass contamination, control measures may include:

- Washing with abundant, fit-for-purpose water
- Trimming the carcass to remove unwanted parts
- Reprocessing or disposal/condemnation of carcasses with visible fecal contamination prior to dressing
- Use of other physical methods approved by the competent authority

[14] Refer to chapter on "Animal Welfare during Slaughter"~~7.5~~ of the WOAH *Terrestrial Animal Health Code*

- Use of chemical decontaminants approved by the competent authority

b. These control measures can be applied alone or in combination at key process steps. Care should be taken to avoid combining interventions that may reduce the efficacy of a given control measure such as conditions that neutralize decontaminants (e.g., inappropriate pH for a rinse or spray).

c. Control measures may be evaluated by qualitative or quantitative metrics to evaluate performance against regulatory limits established by the competent authority.

d. All carcasses~~hickens~~ which drop on the floor should be condemned or reprocessed under specific conditions as determined by the~~the~~ competent authority. Any dropped product should trigger corrective actions as appropriate, such as trimming and re-washing.

Specific scalding control measures for *Campylobacter* and *Salmonella*

a. Contamination during scalding can be minimized by:

- Using pre-scald brush and wash systems
- The use of counter-current, high-flow rates of fit-for-purpose water with an adequate degree of agitation
- Maintaining an optimal scalding temperature[15] that helps to reduce the bacterial load and at a ~~nd~~ duration ~~for~~ specific to the respective type~~s~~ of scalding process~~es~~ (e.g., hard, medium, or soft scalding)
- Using multi-staged tanks, where practical
- Emptying and cleaning tanks at the end of a processing period and cleaning and disinfecting tanks at least daily
- ~~Raising the temperature during processing breaks high enough for a long enough time to kill *Campylobacter* and *Salmonella* in the scalders~~
- Incorporating approved disinfectants (i.e., antimicrobial agents applied to non-living surfaces)~~s~~ as a multi-hurdle approach to reducing contamination
- Using a water treatment to ensure that reused water is fit-for-purpose

b. ~~Specific to free-range: Free-range chickens may be older, have stronger feather follicles and feathers compared to broilers raised in controlled-environment housing systems. Consider adjusting the scalding time and temperatures needed to loosen feathers and ensure adequate defeathering~~

**Scalding Hazard-Based Control Measures**

**Specific to *Campylobacter***

Hard scalding (elevated temperatures, shorter time) has been shown to reduce *Campylobacter* contamination on chicken carcasses.

Specific defeathering and wash control measures for *Campylobacter* and *Salmonella*

Cross-contamination at defeathering can be minimized by:

- Prevention of feather build-up on equipment
- Continuous rinsing of equipment and carcasses with fit-for-purpose water
- Regular adjustment and maintenance of equipment, paying particular attention to the cleaning of moving parts
- Regular inspection, cleaning, and replacement of plucker fingers

[15] Taking into consideration, suitability requirements (i.e. not affecting the skin)

- Ensuring complete removal of debris and any last remaining feathers with a post-plucker wash

Specific feet~~hock~~ and head removal control measures for *Campylobacter* and *Salmonella*

Head pulling/removal should be carried out in a manner that leakage from the crop is prevented. Heads should be pulled downwards to reduce contamination due to crop rupture.

~~a. Specific to free-range: Free-range chickens may have stronger joints, higher bone density, and denser muscle tissue. Ensure processes for hock removal are effective and do not result in contamination of raw chicken meat.~~

Specific rehang control measures for *Campylobacter* and *Salmonella*

Using automated transfer (rehang), where possible, rather than manual transfer of carcasses between the defeathering and evisceration lines can reduce external surface cross-contamination

Specific evisceration control measures for *Campylobacter* and *Salmonella*

Improper evisceration may result in cross-contamination of carcasses. Slaughter establishments should consider monitoring for cross-contamination caused by accidental spillage during venting, opening, evisceration, and dressing. Properly maintained, ~~-~~calibrated, ~~-~~and operated ~~maintained~~ equipment minimizes the risk of ruptured viscera and the spread of gastrointestinal contents or feces, and included: ~~This can be minimized by:~~

- Ensuring birds of similar size are processed together. Inconsistent carcass weight and sizes (for example, because of poor bird size uniformity within a grower house or processing male and female birds together) can result in mis-cuts and fecal contamination
- Ensuring carcasses are shackled correctly and monitored as they move through the process
- Ensuring evisceration blades are kept sharpened and thoroughly clean
- Keeping equipment in good sanitary condition and free of intestinal contents
- Careful adjustment, calibration, and regular maintenance of machinery to effectively handle the type (e.g., size~~, shape, sex,~~ and average live weight) of ~~the~~ birds to be slaughtered~~.~~
- Training in appropriate utensil use, sanitation, and hand washing is essential to reduce cross-contamination ~~These considerations apply to manual evisceration processes as well~~ when manual evisceration is performed. Refer to the Code of Hygienic Practice for Meat (CXC 58-2005) section 9.4: Hygiene Requirements for Slaughter and Dressing to ensure manual evisceration is carried out in accordance with established GHPs~~.~~

Specific crop removal control measures for *Campylobacter* and *Salmonella*

~~a.~~ Where possible, crops should be extracted in a manner that is likely to limit carcass contamination.

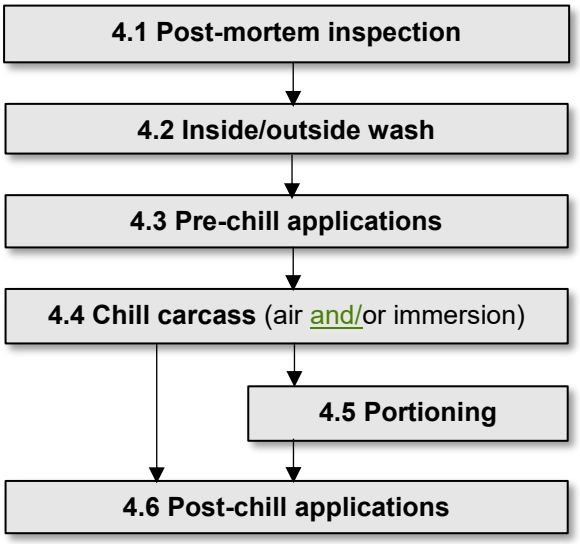
a.

~~b.~~ The use of cropper systems allows the release of accumulated dirty water in the carcass cavity, so efforts to remove collected water prior to chilling should be considered.~~.~~

b.

## 9.4 Post-Evisceration Processing

***Figure 5.*** *Example flow diagram of post-evisceration processing*




*Source: Authors' own elaboration based on CXG 78-2011.*

**Post-Mortem Inspection**

General post-mortem inspection control measures for *Campylobacter* and *Salmonella*

a. Line speed, adequate presentation of the carcass and its viscera, and the amount of light in the facility should be appropriate for effective post-mortem inspection of carcasses for visible contamination, organoleptic defects, and relevant gross pathology.

b. Monitor for fecal contamination prior to pre-chill applications to ensure that chicken carcasses contaminated with visible fecal material do not enter the chiller.

**Inside/Outside Wash**

General inside/outside wash control measures for *Campylobacter* and *Salmonella*

The inside and outside of all carcasses should be thoroughly washed, using potable water with sufficient water pressure and proper direction to remove visible contamination. Appropriate equipment should be used to ensure direct water contact with the carcass. The removal of contaminants may be aided by the use of brushing apparatus installed in line with the inside/outside wash. The water pressure can be validated as sufficient by using qualitative or quantitative metrics to assess performance in relation to the regulatory limits established by the competent authority.

**Pre-Chill Applications**

| **Pre-Chill Applications Hazard-Based Control Measures** |
| --- |
| **General** |

- An on-line reprocessing[16] spray system incorporating acidified sodium chlorite (ASC) has been shown to reduce *Campylobacter* in the whole carcass rinse sample and to reduce the prevalence of *Salmonella* positive carcasses
- Additional significant reductions in *Campylobacter* and *Salmonella* ~~contamination of carcasses~~ can be achieved by post-chilling decontamination sprays or dips
- ~~•~~ Several different chemistries (e.g., trisodium phosphate) have been demonstrated to be effective in reducing carcass contamination at different washing steps. ~~Dipping carcasses in TSP reduced *Campylobacter* and for *Salmonella*, the estimated concentration of viable *microorganisms* was reduced to undetectable levels~~
- **Specific to *Salmonella***
- The use of a pre-chill ASC spray or ASC for dipping carcasses has been shown to reduce *Salmonella* prevalence on carcasses
- ~~Spray application of TSP immediately before carcass chilling was shown to reduce *Salmonella* prevalence~~
- Sequential application of ozonated water to skin and subcutaneous tissue of drumsticks ~~could be applied~~has been shown to reduce *Salmonella* loads below detectable levels

**Chill Carcass (Air and/or Immersion)**

General chill carcass (air and/or immersion) control measures for *Campylobacter* and *Salmonella*

a. Raw chicken meat should be chilled, using air and/or immersion chilling, as quickly as possible to limit the growth of microorganisms on the carcass.

b. Potable water should be used in any chilling system.

c. Design and operation of chilling systems should ensure that the target temperature of chilled carcasses is achieved by the time carcasses exit the chiller.

d. Chilling relies on carcasses reaching temperatures relevant to controlling microbial growth. Care should be taken to monitor carcass temperature, application of processing aids, and pH to ensure efficacy.

e. Specific to air chilling: If water sprays are used during air chilling to prevent desiccation of carcasses, they should be arranged to minimize ~~cross-contamination~~cross-contamination.

f. Specific to immersion chilling:

- Chilled water can be used, or ice made with potable water may be added. When reclaimed or reused water is used, it should be treated and maintained in a way that prevents any increased risk of food contamination
- Water flow should be counter-current and may be agitated to assist cooling and washing action. The water and agitation create a secondary ~~a~~ washing ~~off~~ effect that helps to remove organisms from the carcass~~.~~
- Chlorine in the chill tank may not act as a decontaminating agent directly on the contaminated carcass but ~~by both~~ instead may inactivat~~e~~~~ing~~ *Campylobacter* and *Salmonella* when these are washed off from the carcass into the water, and by preventing re-attachment and cross-contamination. This requires the addition of chlorine at a level sufficient to maintain a free residual chlorine concentration in the water~~.~~
- The number of birds, the water back-flow rate, temperature, pH, and the level of decontaminants (e.g., free available chlorine) in the immersion tank should be carefully balanced and controlled as excess organic matter will reduce the effectiveness of the decontaminant thereby allowing greater cross-contamination of carcasses. Free movement of water around carcasses should be maintained~~.~~
- Post-chilling, any excess water should be allowed to drain away from the carcasses to minimize cross-contamination at subsequent steps in the processing chain~~.~~

[16] Additional washing or trimming step performed without removing the chicken carcass from the main processing line. This is used as a control measure that aims to eliminate fecal or ingesta contamination.

- Drip trays should be considered to prevent cross-contamination from dripping water~~.~~

**Chill Carcass (Air and/or Immersion) Hazard-Based Control Measures**

**General – Immersion Chilling**

- Where possible, immersion chilling of carcasses combined with decontaminants (e.g., according to their specified permissible limits by competent authority (e.g., chlorine, organic acids, cetylpyridinium chloride [CPC]) can reduce the concentration of *Campylobacter* and *Salmonella* and is more effective than air chilling in terms of reducing surface concentrations on carcasses
- Where considered necessary for control of *Campylobacter* and *Salmonella,* antimicrobial processing aids may be added to the chiller water. These should be approved by the competent authority within their specified permissible limits and may include, among others:
  - Free chlorine (as produced by chlorine gas, sodium-hypochlorite, calcium hypochlorite tablets or electrolytically generated hypochlorous acid)
  - Organic acids (e.g., citric, lactic or peracetic acid)
  - Other oxidants (e.g., hydrogen peroxide, peroxyacids, chlorine dioxide, acidified sodium chlorite)

**Specific to *Campylobacter* – Air and/or Immersion Chilling**

Forced air chilling (blast chilling) and/or immersion chilling ~~may~~ has been shown to reduce the concentration of *Campylobacter* on chicken carcasses

~~**Specific to *Salmonella* – Immersion Chilling**~~

~~Immersion chilling in water treated with antimicrobial processing aids according to their specified permissible limits by competent authority can reduce *Salmonella* prevalence~~

**Portioning**

~~This section addresses the control of *Campylobacter* and *Salmonella* during p~~Portioning ~~which~~ is the cutting up (e.g., trimming, deboning, slicing, dicing) of chilled, raw chicken carcasses into parts~~. This is done~~ prior to packaging or further processing. Portioning chicken carcasses can lead to ~~cross contamination~~cross-contamination between carcasses and parts and from the surface tissues to the internal, uncontaminated muscle tissue.

General portioning control measures for *Campylobacter* and *Salmonella*

a. Portioning should be carried out:

- ~~The operation should be done i~~In a way to avoid ~~cross contamination~~cross-contamination by separating portioning areas from earlier, higher-contamination operations and with unidirectional product and personnel flow~~.~~
- ~~Whenever possible, portioning operations should be done i~~In exclusive, isolated, and pre-chilled areas, with adequate temperature control and recording equipment~~.~~

b. Ensure an orderly workflow by controlling work-in-process volumes and implement limits for time and temperature based on scientific criteria.

c. Minimize the product-to-product, handlers-to-product, and product-to-surface contact, especially for skin-on parts where *Campylobacter* and *Salmonella* are frequently present on the skin.

~~b.~~d. Smooth, preferably self-cleaning conveyor belts should be used to minimize ~~exudate~~ accumulation of raw chicken meat, trimmings, and byproducts~~buildup~~. The work surface should have effective drainage to prevent liquid buildup.

~~c.~~e. Accumulation of raw chicken meat, trimmings, and byproducts on processing lines should be avoided to prevent an increase in product temperature during operations.

~~d.~~f. ~~Temperatures can rise during mechanical deboning and throughout portioning.~~ Maintain product ~~at~~ temperatures at those that prevent the growth of *Campylobacter* and *Salmonella* during mechanical boning and throughout portioning and staging (e.g., through pre-chilled rooms, chilled tables, and short exposure times).

~~e.~~a. ~~Ensure an orderly workflow by controlling work in process volumes and implement limits for time and temperature based on scientific criteria.~~

~~f.~~a. ~~Minimize the product to product, handlers to product, and product to surface contact, especially for skin on parts where *Campylobacter* and *Salmonella* are frequently present on the skin.~~

**Portioning Hazard-Based Control Measures**

**General**

Where considered necessary for control of *Campylobacter*, and *Salmonella*, antimicrobial processing aids (e.g., organic acids, peroxyacids) may be applied, if authorized by competent authority. Products used should be ~~approved by the competent authority and~~ applied within their specified permissible limits with documented control of concentration, pH, oxygen reduction potential, temperature and contact time~~.~~

**Post-Chill Applications**

**Post-Chill Applications Hazard-Based Control Measures**

**Specific to *Salmonella***

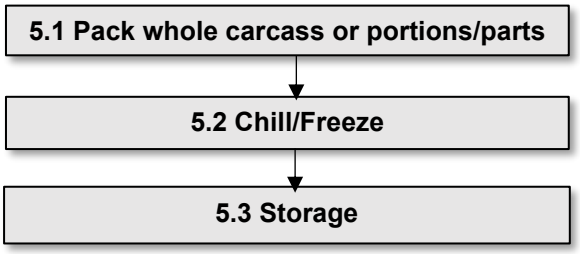
- Several different antimicrobial processing aids have been demonstrated to be effective in reducing carcass contamination at different washing steps and should be used to permissible limits specified by a competent authority
- The use of ASC post-chill has been shown to reduce the prevalence of *Salmonella* positive carcasses
- Spray applications of chlorinated water have been shown to reduce the prevalence of *Salmonella*-positive carcasses
- A chlorine dioxide generating system applied as a dip post-chill resulted in a reduction in *Salmonella* prevalence
- Immersion in peroxyacetic acid (PAA) has been shown to reduce *Salmonella* populations
- High pressure processing may be effective in reducing *Salmonella* in chicken liver

**Specific to *Campylobacter***

- Spray applications of PAA have been shown to reduce the prevalence of *Campylobacter* positive carcasses

## 9.5 Packaging and Storage at Processing Plant

***Figure 6.*** *Example flow diagram of packaging and storage at processing plant*




*Source: Authors' own elaboration based on CXG 78-2011.*

**Pack whole carcass or portions/parts**

General packaging control measures for *Campylobacter* and *Salmonella*

a. Care should be taken when packaging to minimize external contamination of the pack, e.g., by use of leakproof packaging or absorbent pads.

b. Pre-packed chicken products intended to be cooked by the consumer should be labelled with safe handling, cooking, and storage instructions as appropriate to the national situation.

**Packaging Hazard-Based Control Measures**

**General**

Various doses of Gamma rays or electron beams applied to warm, chilled, or frozen carcasses have been shown to be effective at eliminating *Campylobacter* and *Salmonella*. Where irradiation is permitted, levels should be validated and approved by the competent authority

**Chill/Freeze**

**Chill/Freeze Hazard-Based Control Measures**

**Specific to *Campylobacter***

- Freezing carcasses has been shown to reduce *Campylobacter* prevalence in chicken liver and meat
- Crust freezing using continuous carbon dioxide belt freezing of chicken meat products has been shown to reduce level of *Campylobacter* on the surface of chicken meat

**Storage**

Specific storage control measures for *Salmonella*

Products should be stored frozen or at temperatures ~~that~~ sufficient to prevent the growth of *Salmonella*. Temperature recommendations should be determined by a competent authority and while differing by country of origin, ~~but~~ are ~~typically~~typically ~~3~~ 18 to -5°C or below and ~~should be determined by a competent authority~~. Packaging in modified atmosphere does not prevent growth of *Salmonella* if temperature abuse occurs.

## 9.6 Distribution, Retail, and Consumers

***Figure 7.*** *Example flow diagram of product distribution channels*


*Source: Authors' own elaboration based on CXG 78-2011.*

**Transport Product (Steps 6.1, 6.3, and 6.5)**

General transport product control measures for *Campylobacter* and *Salmonella*

a. For GHP-based control measures for all aspects of transport, refer to the *Code of Practice – General Principles of Food Hygiene* (CXC 1-1969) and the *Code of Hygienic Practice for Meat* (CXC 58- 2005).

b. Products should be transported at temperatures ~~(frozen or chilled at -18°C to 5°C)~~ that prevent the growth of *Campylobacter* and *Salmonella* and in a manner that prevents cross-contamination with other foods and surfaces.

**Wholesale premises (Step 6.2)**

General wholesale premises control measures for *Campylobacter* and *Salmonella*

Products should be stored at temperatures~~es~~ ~~(frozen or chilled at -18°C to 5°C)~~ that prevent the growth of *Campylobacter* and *Salmonella* and in a manner that prevents cross-contamination with other foods and surfaces.

**Retail and Food Service (Step 6.4)**

**Retail**

General retail control measures for *Campylobacter* and *Salmonella*

a. Hygiene measures should be in place to prevent cross-contamination between raw chicken meat, surfaces, cutting boards, utensils, and other food, especially cooked, ready-to-eat products.

b. Retailers should separate raw chicken meat from cooked or ready-to-eat products.

c. Hands should be washed and sanitized before and after handling raw chicken meat. Retailers may also provide customers with the means to sanitize hands before and after handling raw chicken meat packs.

d. Where products are packed at retail for individual selection by customers, packs should be leak-proof.

e. Extra packaging should be supplied at the display counter to allow customers to separate packaged raw chicken meat from other purchases.

f. Products should be stored at temperatures ~~(frozen or chilled at -18°C to 5°C)~~ that prevent the growth of *Campylobacter* and *Salmonella* and in a manner that prevents cross-contamination with other foods and surfaces ~~(-18°C to 5°C)~~.

**Food Service**

General food service control measures for *Campylobacter* and *Salmonella*

a. For GHP-based control measures, also refer to the *Code of Hygienic Practice for Precooked and Cooked Foods in Mass Catering* (CXC 39-1993).

b. Thawing of frozen chicken should be carried out in a manner that minimizes the potential for growth of microorganisms and prevents cross-contamination (e.g., refrigerator thawing at ≤ 5 °C, sealed cold-water submersion with frequent water changes or microwave defrost followed by immediate cooking). Room-temperature thawing should be avoided.[17]

c. Washing of raw chicken meat should not be carried out as it is likely to spread contamination.

d. Chicken meat should be cooked according to a process that is capable of reaching an internal temperature, as determined by a competent authority, that can inactivate or kill *Campylobacter* and *Salmonella*.

e. Food service operators should be fully trained and aware of the differences between raw and cooked chicken products in relation to food safety and ensure separation at all times.

~~d.~~

~~e.~~f. Food service operators should have hygiene measures in place that minimize cross-contamination between raw chicken and hands, contact surfaces, cutting boards, and utensils, and should prevent contamination of other foods, especially ready-to-eat foods.

~~f.~~g. Products should be stored and transported at temperatures [(frozen or chilled at -18°C to 5°C)] that prevent the growth of *Campylobacter* and *Salmonella* and in a manner that prevents cross-contamination with other foods and surfaces. Home delivery services should consider safe storage and transportation where space may be ~~limited~~limited, and refrigeration may not be available. Where home-delivery or meal-kit services are used, validated insulated packaging and coolant systems should maintain safe temperatures throughout transit and safely segregate raw and ready-to-eat foods.

**Consumers (Step 6.6)**

General control measures for *Campylobacter* and *Salmonella*

a. Consumer education should focus on:

- Proper handwashing and other hygienic measures
- Separating raw and cooked foods to prevent cross-contamination.
- Use~~This includes using~~ separate equipment and utensils such as knives and cutting boards for raw and cooked foods
- Cooking foods to safe minimum internal temperatures
- Prevention of temperature abuse including during transport

The WHO Five keys to safer food[18] can assist in this process.

b. Special attention should be paid to the education of all people preparing food, and particularly to all people preparing food for vulnerable populations (e.g., the young, elderly, pregnant, and those with compromised immunity).

c. The above information for consumers should be provided in appropriate languages and forms. Multiple channels such as the internet, media, public health providers, healthcare professionals, food hygiene trainers, product labels, meal-kit recipes, posters and pamphlets, school curricula and cooking demonstrations should be considered when disseminating educational information.

d. Washing raw chicken in the kitchen should be discouraged to minimize the possibility of cross-contamination of other foods and surfaces that come into contact with food and humans.

e. Consumers should wash and disinfect food-contact surfaces, including chopping boards, bowls, plates, knives, and other utensils after handling raw chicken to significantly reduce the potential for cross-contamination in

[17] Refer to the *Code of Practice for the Processing and Handling of Quick Frozen Foods* (CXC 8-1976)
[18] https://www.who.int/publications/i/item/9789241594639

the kitchen, and to cooked, ready-to-eat foods.

**Retail, Food Service, and Consumer Hazard-based Control Measures**

**General**

~~Chicken meat should be cooked according to a process that is capable of reaching an internal temperature, as determined by a competent authority, that can inactivate or kill *Campylobacter* and *Salmonella*~~

## 10. RISK-BASED CONTROL MEASURES

GHPs provide~~s~~ the foundation for most food safety control systems. Where possible and practical, food safety control systems should incorporate hazard-based control measures and risk assessment to determine risk-based control measures. Identification and implementation of risk-based control measures can be elaborated by the application of a RMF process as advocated in the *Principles and Guidelines for the Conduct of Microbiological Risk Management* (MRM) (CXC 63-2007).

While these guidelines provide generic guidance on the development of GHPs and hazard-based control measures for *Campylobacter* and *Salmonella*, the development of risk-based control measures for application at single or multiple steps in the food chain are primarily the domain of competent authorities at the national level. Industry may derive risk-based measures to facilitate the application of process control systems.

**Development of risk-based control measures**

Competent authorities operating at the national level should develop risk-based control measures for *Campylobacter* and *Salmonella* where possible and practical. Risk modeling tools used to explore risk management options and contribute to risk management decisions should be fit for purpose. The risk manager needs to understand the capability and limitations of the risk modeling tools they select.[19] When developing risk-based control measures, competent authorities may use quantitative examples of the likely level of control of a hazard at certain steps in the generic food chain in this document, as a peer-reviewed scientific resource. Competent authorities formulating risk management metrics as regulatory control measures should apply a methodology that is scientifically robust and transparent.

**Availability of a web-based decision support tool**

FAO/WHO developed through JEMRA a web-based decision support tool[20] to assist with the development of risk-based control measures for *Campylobacter* and *Salmonella* in the raw chicken meat food chain at the national level[21]. This web-based tool can be used, complementary to these guidelines, to model different food chain scenarios and to estimate relative risk reduction and/or ranking consequential to:

- Implementation of a specific control measure at a particular step in the food chain (from primary production through to consumption),
- Implementation of a combination of control measures at different steps in the food chain, and
- Modeling of different food chain scenarios similar to the flow diagrams presented in this document

Industry may also make use of the decision support tool when designing premise-specific food safety programs that may differ in the availability of specific control measures.

The user of the decision support tool should:

- Take responsibility for the appropriateness of the scientific data that is introduced
- Be aware of the uncertainty that inevitably accompanies risk modeling and, in conjunction with the risk manager, use the web-based tool to *explore* risk management options and *inform* risk management decisions, rather than provide a prescriptive base

## 11. VALIDATION, IMPLEMENTATION, AND VERIFICATION OF CONTROL MEASURES

[19] *Principles and Guidelines for the Conduct of Microbiological Risk Assessment* (CAC/GL 30-1999)
[20] Initiated after FAO/WHO Technical Meeting on *Salmonella* and *Campylobacter* in chicken meat. Rome 4-8 May 2009. Trialed November 2009. Reviewed April 2010.
[21] www.mramodels.org

**Validation**

Refer to the *Guidelines for the Validation of Food Safety Control Measures* (CXG 69 -2008). Note: GHP-based control measures are not subject to validation. Prior to the validation of hazard-based control measures for *Campylobacter* and/or *Salmonella*, the following tasks should be completed:

- Identification of the specific measures to be validated. This would include consideration of any measures approved by the competent authority and whether any measure has already been validated in a way that is applicable and appropriate to specific commercial use, such that further validation is not necessary
- Identification of any existing food safety outcome or target, established by a competent authority or industry. Industry may set stricter targets than those set by a competent authority

Validation of measures may be carried out by a competent authority and/or industry and should be carried out prior to implementation. Where validation is undertaken for a measure based on a hazard control for *Campylobacter* and/or *Salmonella,* evidence will need to be obtained to show that the measure is capable of controlling *Campylobacter* and/or *Salmonella* to a specified target or outcome. This may be achieved by the use of a single measure or a combination of measures. The *Guidelines for the Validation of Food Safety Control Measures* (CXG 69 -2008) provide detailed advice on the validation process (section VI).

**Implementation**

Refer to section 9.2 of the *Code of Hygienic Practice for Meat* (CXC 58-2005) and the *General Principles of Food Hygiene* (CXC 1-1969).

Industry has the primary responsibility for implementing, documenting, applying, and supervising process control systems to ensure the safety and suitability of raw chicken meat that they produce or handle. These activities should incorporate GHPs and validated measures (HACCP) for control of *Campylobacter* and/or *Salmonella* as appropriate to national government requirements and industry specific circumstances.

Implementation involves:

- ~~Determining the~~Giving effect ~~of~~ to the selected control measures
- Developing an implementation plan
- Communicating the control measures and implementation plan with stakeholders
- Ensuring that the regulatory framework and infrastructure are in place for implementation
- Establishing an evaluation process to assess whether the control measures have been properly implemented

The documented process control systems should describe the activities applied including any sampling procedures, specified targets, such as performance objectives or performance criteria set specifically for *Campylobacter* and/or *Salmonella*, industry verification activities, and corrective and preventive actions.

In regulatory systems, the competent authority should provide guidelines and other implementation tools for the development of process control systems to industry as appropriate. The competent authority may choose to approve the documented process control systems for GHPs and HACCP and stipulate verification frequencies.

**Verification**

Refer to section 9.2 of the *Code of Hygienic Practice for Meat* (CXC 58-2005) and section IV of the *Guidelines for the Validation of Food Safety Control Measures* (CXG 69 -2008).

Industry verification should demonstrate that all control measures for *Campylobacter* and/or *Salmonella* have been implemented as intended. Verification should include observation of processing activities, documentary checks, and sampling for *Campylobacter* and/or *Salmonella* testing as appropriate. Verification frequency should vary according to the operational aspects of process control, the historical performance of the establishment and the results of verification itself.

In regulatory systems, the competent authority[6] should verify that all regulatory control measures implemented by industry comply with regulatory requirements as appropriate for control of *Campylobacter* and/or *Salmonella*. Microbiological testing requirements should be provided for verification of HACCP systems where specific targets

for control of *Campylobacter* and/or *Salmonella* have been stipulated. ~~[Verification procedures should account for the presence of persistent viable but non-culturable (VBNC) forms of *Campylobacter* and *Salmonella* that may not be addressed by control measures (e.g., chilling, freezing, organic acid interventions).]~~

The competent authority[6] may choose to use a competent body (e.g., independent verifiers, ~~-~~academia, trade associations, professional societies) to undertake specific verification activities in relation to the industry's process control systems. Where this occurs, the competent authority should stipulate specific functions to be carried out.

## 12. MONITORING AND REVIEW

Monitoring the ~~–~~effectiveness of control measures and review of food safety control systems are essential components of the application of ~~a~~an RMF[5~~5~~]. It contributes to process control verification and demonstrating progress towards achieving public health goals. Monitoring systems allow for the precise application of control measures such as breeder flock status which informs control measures for day-old progeny and pre-slaughter monitoring of broilers that can inform control measures for slaughter of infected flocks. These data, together with public health surveillance data, are used in risk assessments and risk profiles of pathogen/food combinations to prioritize foods and pathogens considered to be a country's highest priority (e.g., those strains with virulence factors capable of causing severe illness or considered to cause significant illness in that country).

Information on the level of control of *Campylobacter* and *Salmonella* at appropriate points in the food chain can be used for several purposes. For example, to validate and/or verify outcomes of food control measures, to monitor compliance with hazard-based and risk-based regulatory goals, and to help prioritize regulatory efforts to reduce foodborne disease.~~–~~ Systematic review of monitoring information allows the competent authority and relevant stakeholders to make decisions in terms of the overall effectiveness of the food safety control systems and make improvements where necessary. Refer to the *Principles and Guidelines for the Establishment and Application of Microbiological Criteria Related to Foods* (CXG 21-1997).

### Monitoring

Monitoring should be carried out at appropriate steps[22] in the food chain using randomized or targeted sampling.

Primary production and processing:

Examples of monitoring systems for *Campylobacter* and/or *Salmonella* throughout primary production and processing include:

- Environmental sampling (e.g., drag swabs, boot swabs, ~~litter~~cloacal samples, feed, lining paper from chick trays) and surveillance at breeder farms and hatcheries to inform flock risk, status, and preharvest control measures
- Environmental sampling prior to transport to slaughter to determine flock status and permit logistic scheduling and/or channeling of positive chickens for specific processing steps such as heat treatment or freezing
- Whole bird rinse, neck skin, parts, or other sampling at the end of processing (e.g., after immersion or air chilling) to verify compliance with hazard-based regulatory or company performance goals. A moving window approach as described in Section 4.9 of CXG 21-1997 can be considered

Regulatory:

Regulatory monitoring programs should be designed in consultation with relevant stakeholders and the results and trend analyses be made available to them in a timely manner. Given the importance of monitoring data in risk management, sampling and testing components should be standardized on a national basis and be subject to quality assurance. The type of data collected in monitoring systems should be appropriate for the outcomes sought. Examples of monitoring systems in a regulatory environment include:

- Ongoing or periodic national or regional surveys for establishing baseline levels of contamination and assisting in the development of regulatory performance goals and pathogen reduction programs within the food chain
- Sampling and trend analysis of chicken meat and ceca during processing and/or ~~of~~ chicken meat at retail ~~products~~ to determine contamination trends ~~post-processing~~

[22] Recommendations on surveillance in poultry flocks for *Salmonella* are provided in the WOAH *Terrestrial Animal Health Code*, Chapter ~~6.6~~ "Prevention, Detection and Control of *Salmonella* in Poultry"

- ~~National or regional surveys for establishing baseline levels of contamination and assisting in the development of regulatory performance goals and pathogen reduction programs within the food chain.~~
- Routine whole genome sequencing of *Salmonella* isolates from feed, *Salmonella* and *Campylobacter* isolates from live chickens, and from sampling retail meat to provide information on circulating strains, ~~presence of antimicrobial resistance genes,~~ and to assist in outbreak investigations

Laboratory testing of raw chicken meat during and after processing is vital to surveillance and verification activities. The results should be used to determine prevalence, and when possible, quantification, of pathogens of public health concern as determined by a competent authority.

Where live *Salmonella* vaccines are used, precise testing that differentiates between vaccine strains and field strains of the pathogen is essential. Otherwise, there is a risk that the use of the vaccine increases the prevalence of positive *Salmonella* results from slaughterhouse samples. Utilizing proper diagnostic methods, such as molecular tests, serological tests and serotyping, is necessary for monitoring vaccination efficacy and implementing appropriate biosecurity measures.

Wherever possible, monitoring information from the food chain should be combined with human health surveillance data and food source attribution data to validate risk-based control measures and to verify progress towards risk-reduction goals. Activities supporting an~~d~~ integrated response include:

- Surveillance of clinical salmonellosis and campylobacteriosis in humans
- Epidemiological investigations, including outbreaks and sporadic cases
- Surveillance for antimicrobial resistance in isolates from clinical, bird, and food samples. Refer to the *Guidelines on Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance* (CXG 94-2021)

Reliable surveillance for *Salmonella* spp. and *Campylobacter* spp. should utilize reference methods validated by independent bodies or official organizations that are accredited for the use of international standards for microbiological testing. *Salmonella enterica* is one of two *Salmonella* species that represent over 2500 distinct serovars with a small subset of these representing most human salmonellosis infections across the globe. Because of this, where possible, a robust surveillance system should include methods that can distinguish *Salmonella* serovars of differing levels of public health concern. Serovars of higher concern to human health vary geographically and temporally and should be prioritized for monitoring and control at the national level.~~—~~ These serovars can be distinguished by a variety of technologies and cross-referenced with clinical data to determine public health priorities. ~~It has also been recognized that some strains of *Campylobacter* spp. are highly virulent and antimicrobial resistant.~~ This highlights the importance of laboratory testing to ensure pathogens of public health concern are identified ~~prior to raw chicken meat entering commerce~~.

**Review**

Monitoring data on *Campylobacter* and *Salmonella* and associated risks should be reviewed on a periodic basis to provide information on the effectiveness of risk management decisions and actions. *Campylobacter* and *Salmonella* spp. sampling results should be shared with competent authorities so that the information can be integrated into trend analyses.

Periodic review of monitoring data at relevant process steps should be used to inform future decisions on selection of specific control measures and provide a basis for their validation.

Information gained from monitoring in the food chain should be integrated with public health surveillance, food source attribution data, and withdrawal and recall data, where available, to evaluate and review the effectiveness of control measures.

Where monitoring of hazards or risks indicates that regulatory performance goals are not being achieved, risk management strategies and/or control measures should be reviewed.